A Transport Protocol for Content-Based Publish/Subscribe Networks

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Advisors: Antonio Carzaniga, Fernando Pedone

Outline

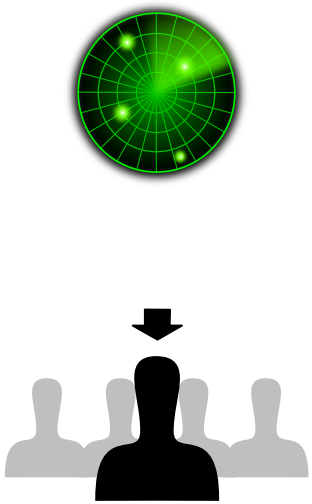
- Publish-Subscribe communication paradigm
  - ▷ Content-based
  - ▷ Best-effort
- Problem and solution outline
- Transport Protocol
  - ▷ FIFO ordering
  - ▷ Reliable delivery

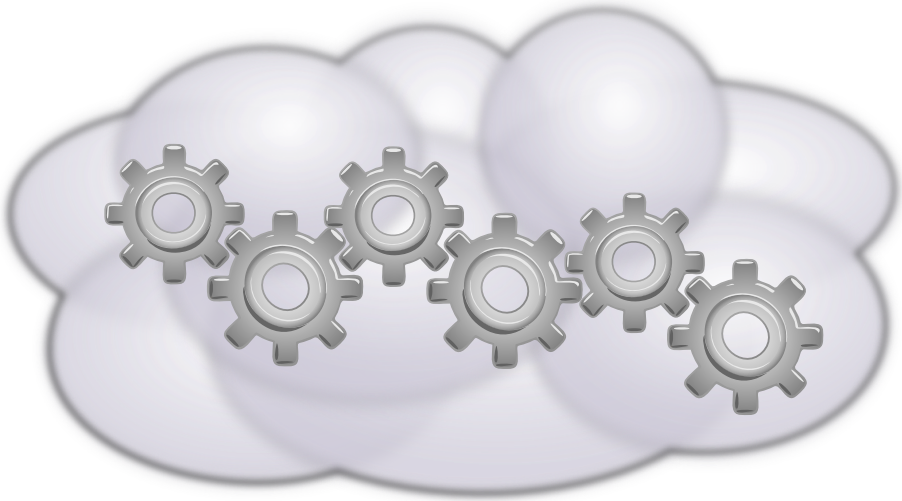
Publish/Subscribe Network

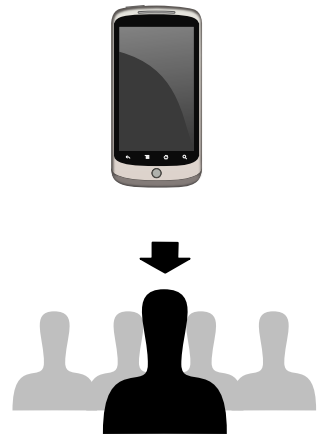
Publishers

Event processing/dissemination

Subscribers







People
Devices
Systems

Overlay network

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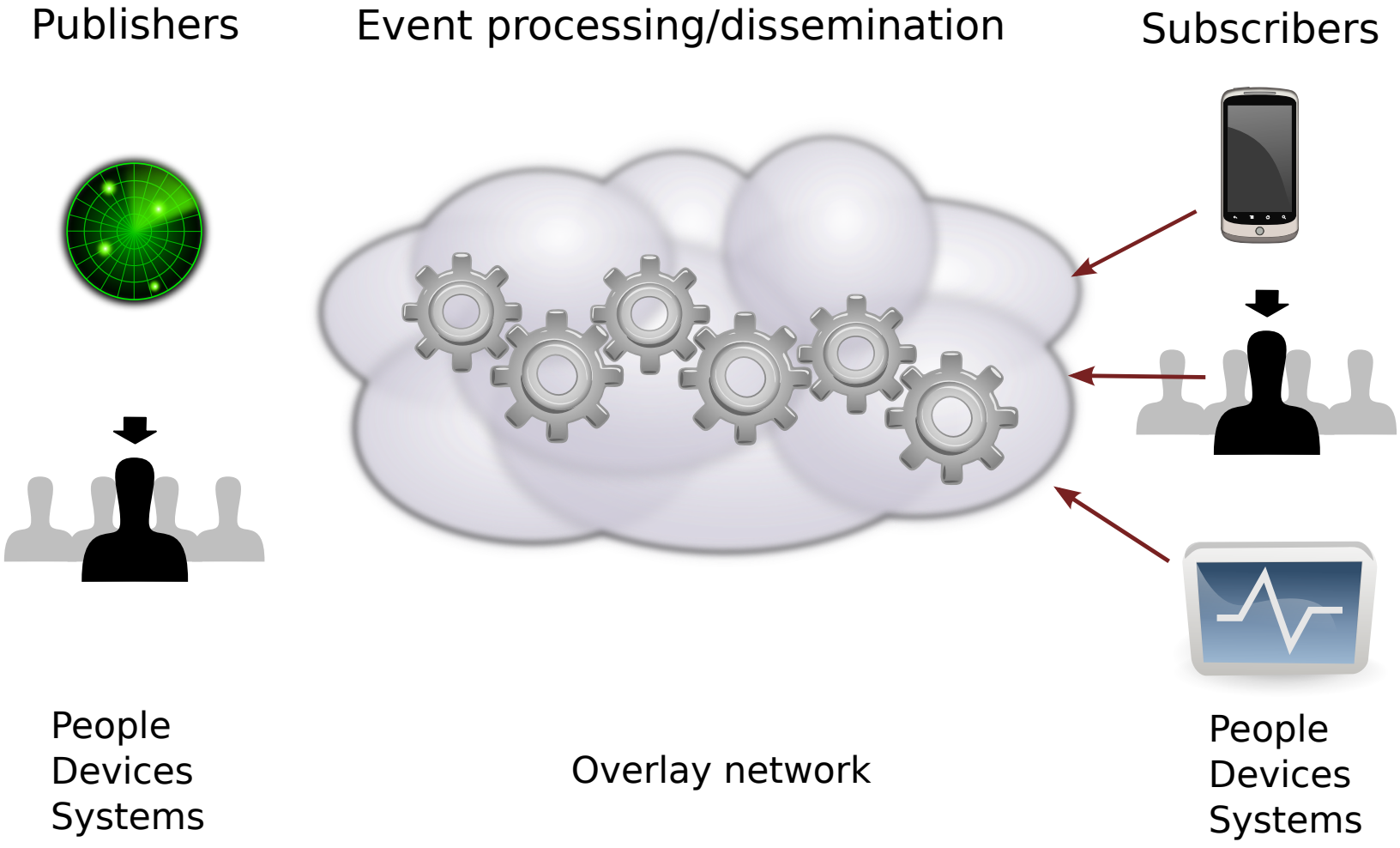
Publish/Subscribe Network



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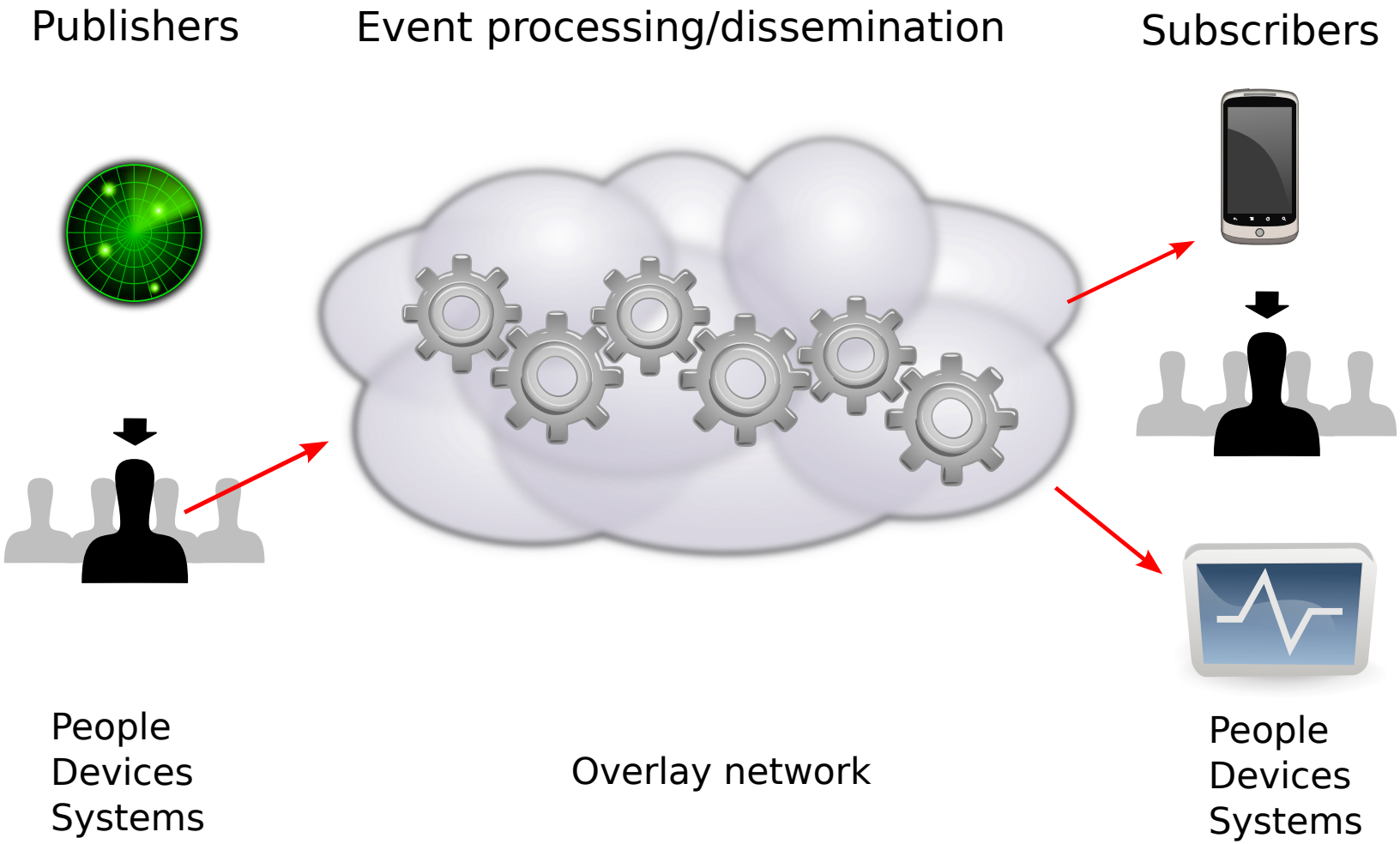

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- Massively multiplayer online games (MMOG)millions of events per second during peak periods.

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Publish/Subscribe

- Distriuted, asynchronous, large scale service
- A set of algorithms and potocols for routing events

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Standards

- Java Messaging Service (JMS)
- Advanced Message Queuing Protocol (AMQP)
- Data Distribution Service (DDS)

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Categorizing based on many factors such as:

- Event model: topic-based, **content-based**
- Ordering and delivery guarantees: guaranteed, **best-effort**

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The focus of thesis is **content-based, best-effort** networks

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Guaranteed delivery and FIFO ordering

- Necessary for some applications
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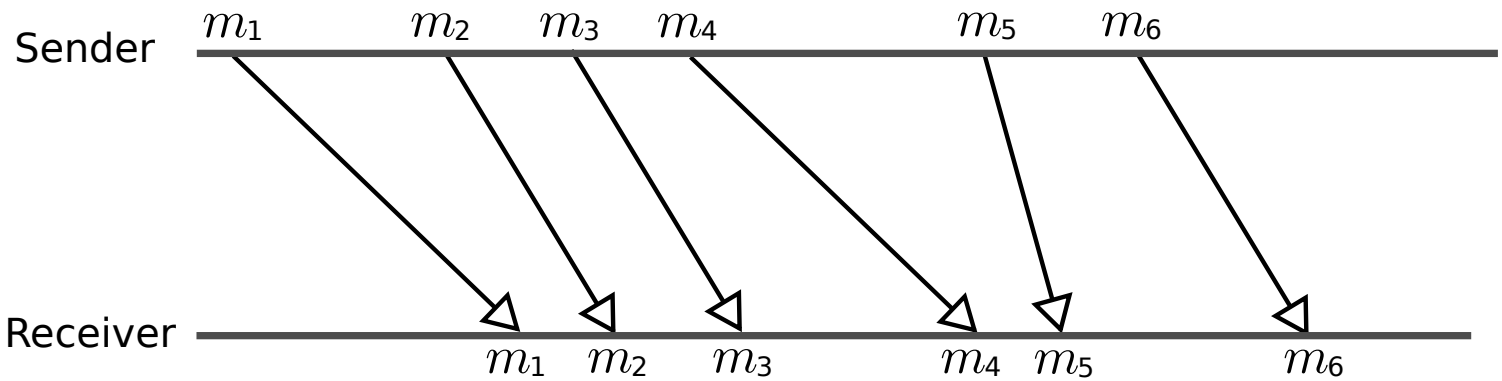
- Datagram-like messages
  - ▷ Out-of-order deliveries
  - ▷ Message loss
- Siena B-DRP

FIFO Ordering



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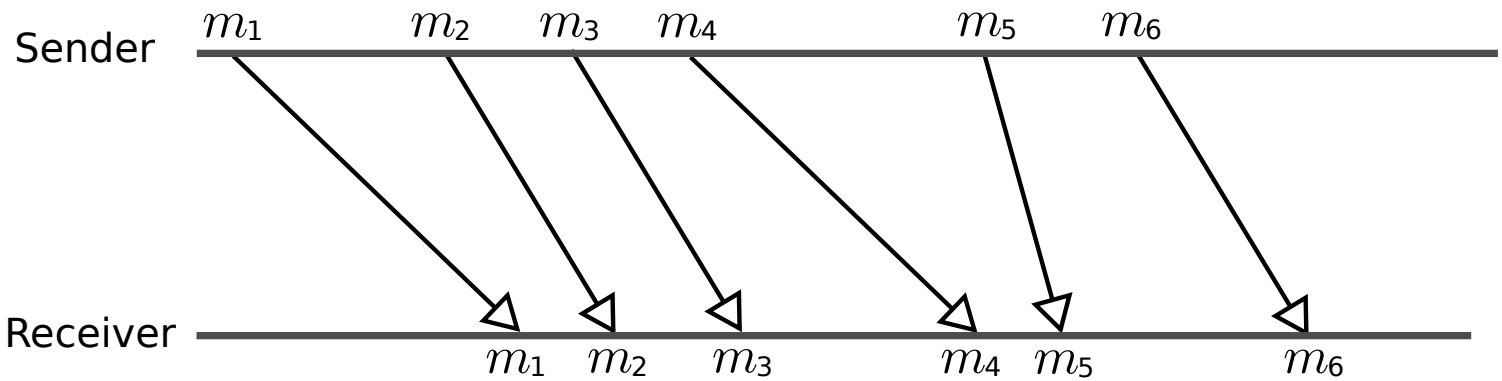
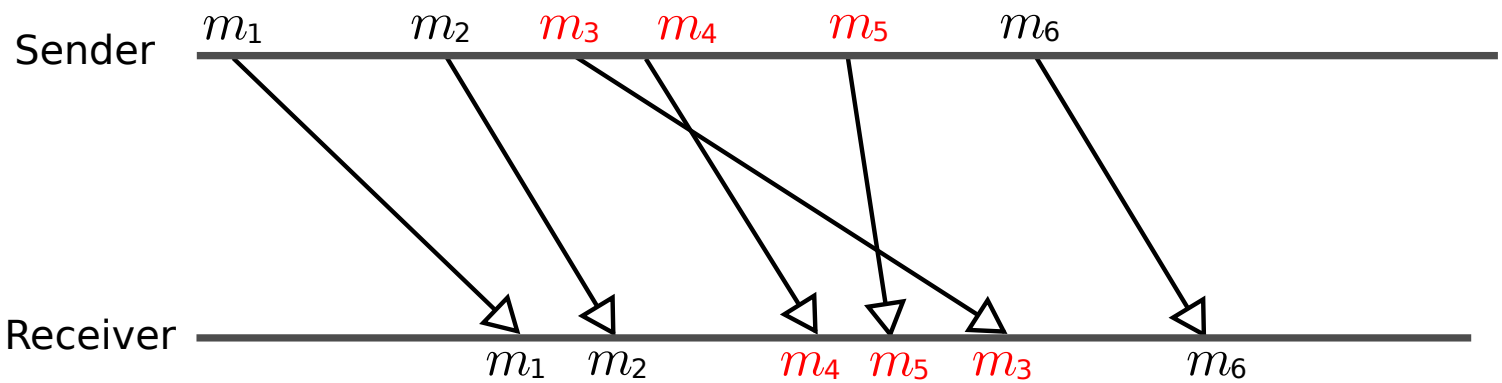
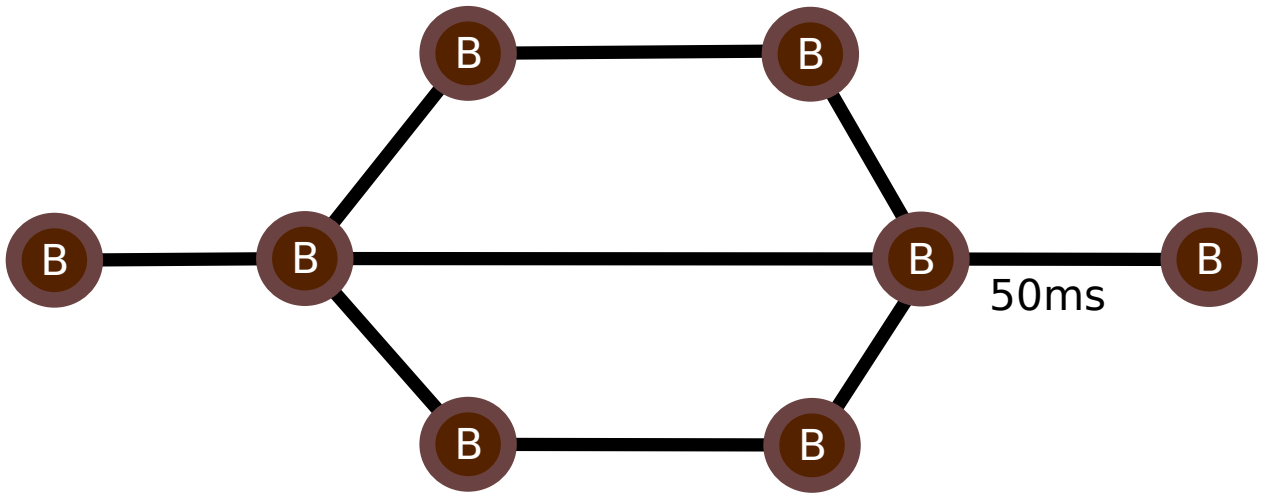


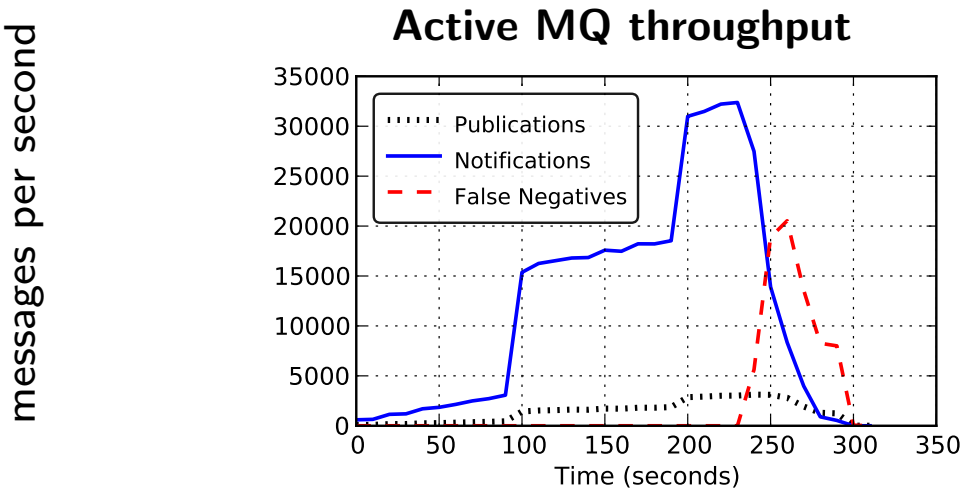


Experiment Setup



- 8-brokers
- Each broker serves 50 clients
- 50 publishers, 350 subscribers

ActiveMQ vs. B-DRP



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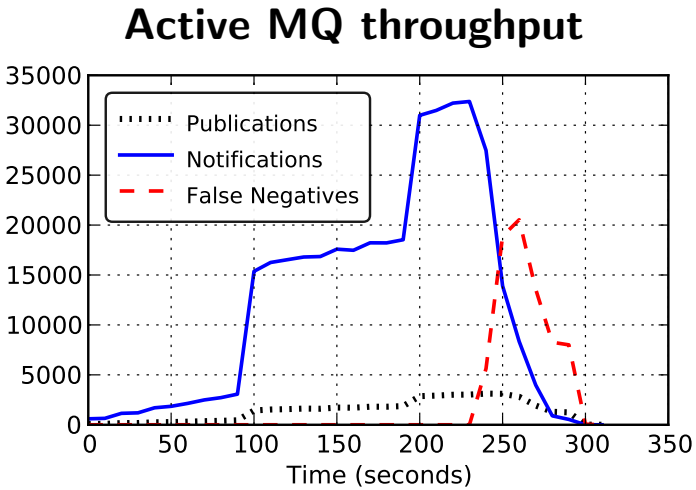

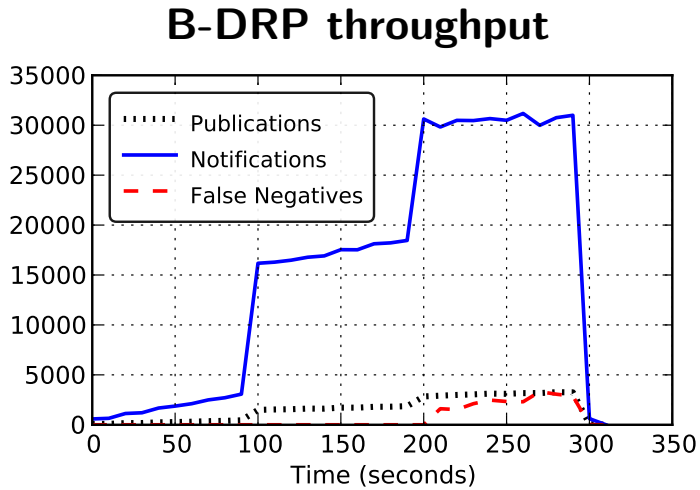

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messages per second

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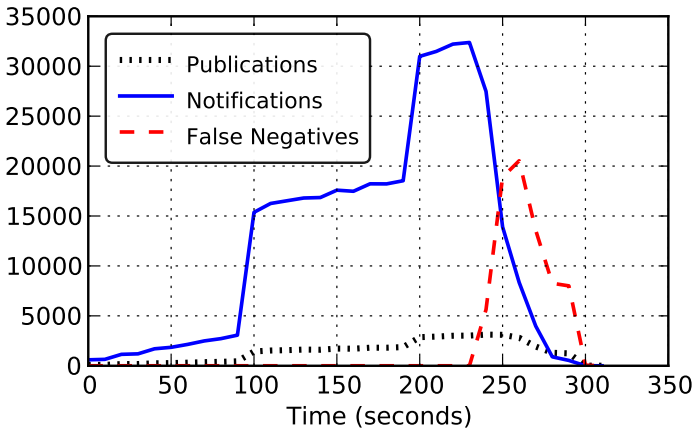
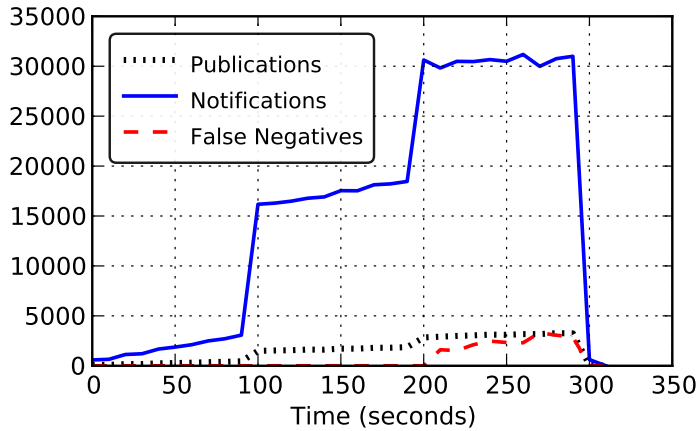


B-DRP throughput



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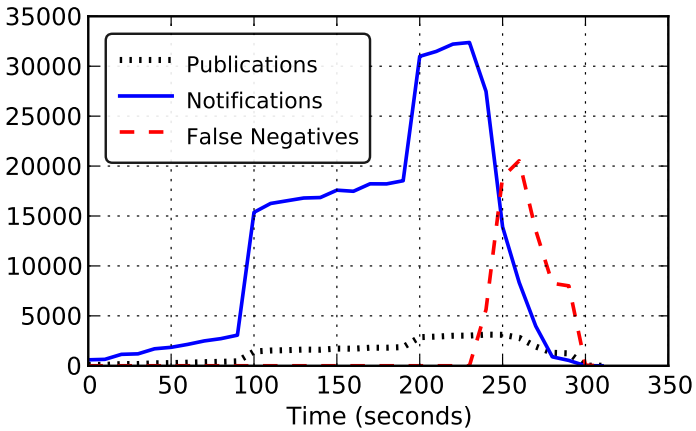
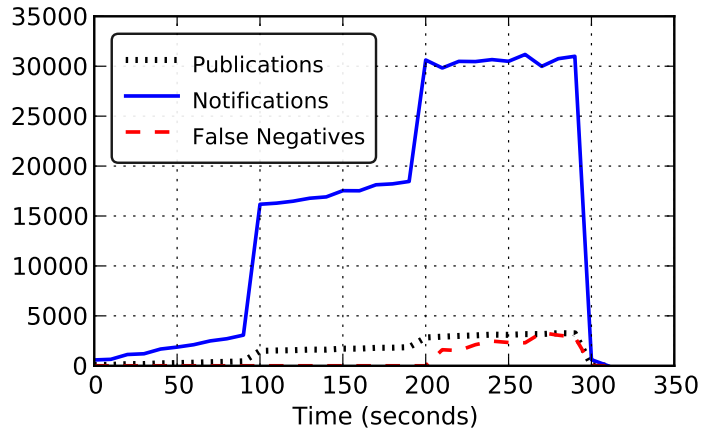


B-DRP throughput



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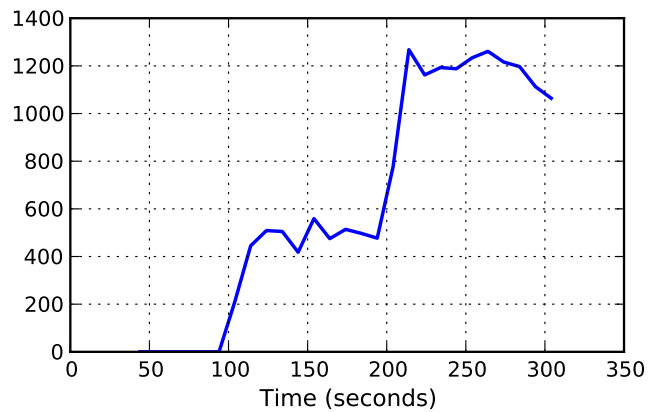
B-DRP FIFO violations



Nearly 173,000 FIFO violations

Proposal

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- **End-to-end "transport protocol"**

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- Three main purposes:
  - **Message ordering**
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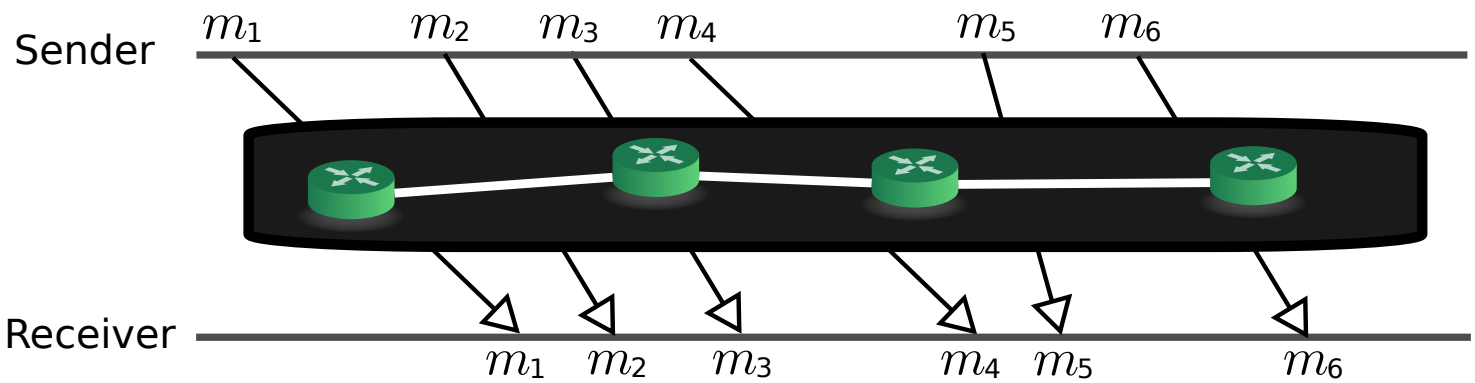
- But there are some fundamental differences...

Sequence Numbers



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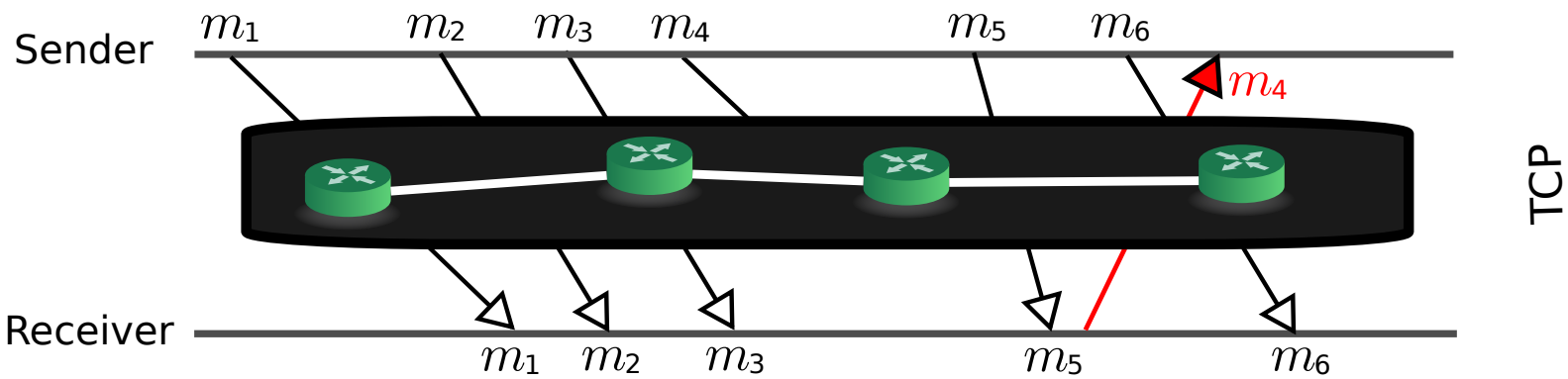

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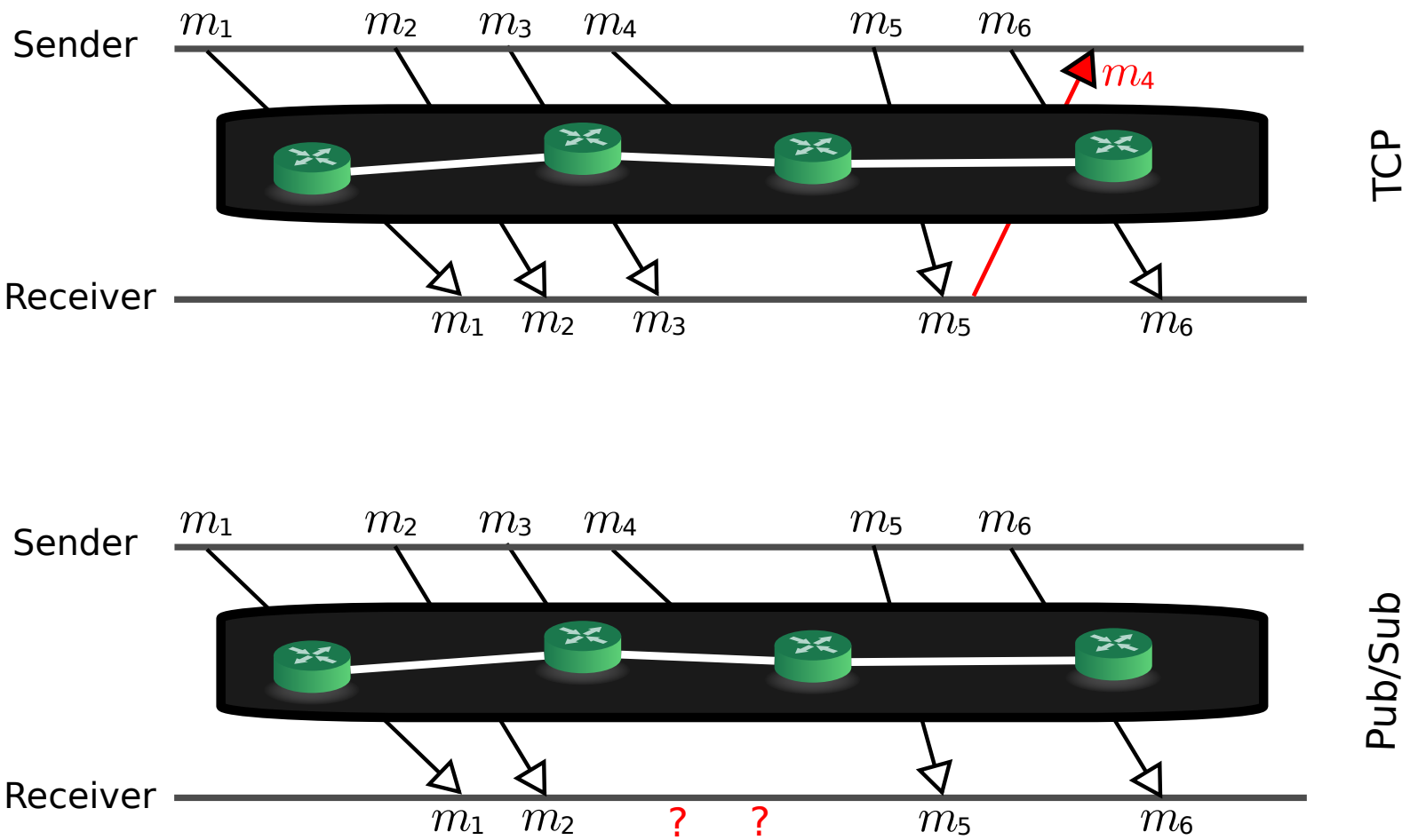

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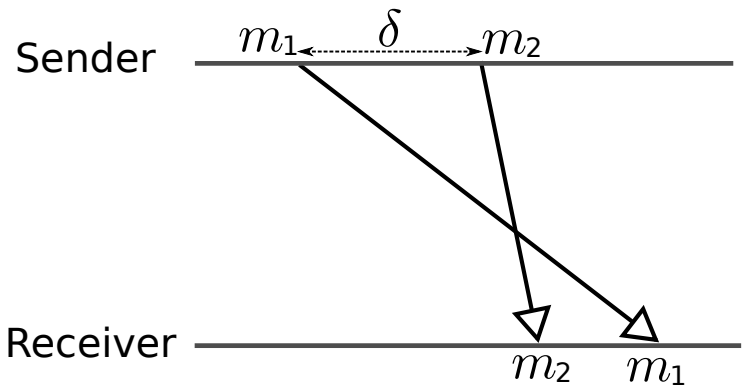

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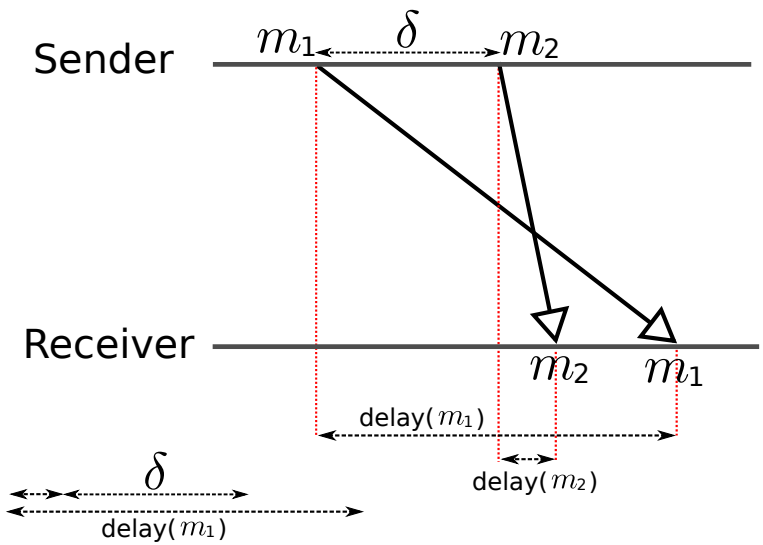

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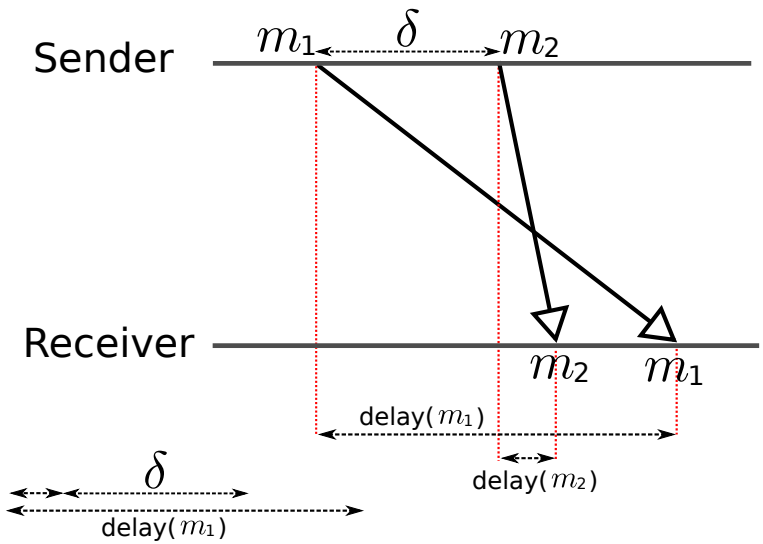

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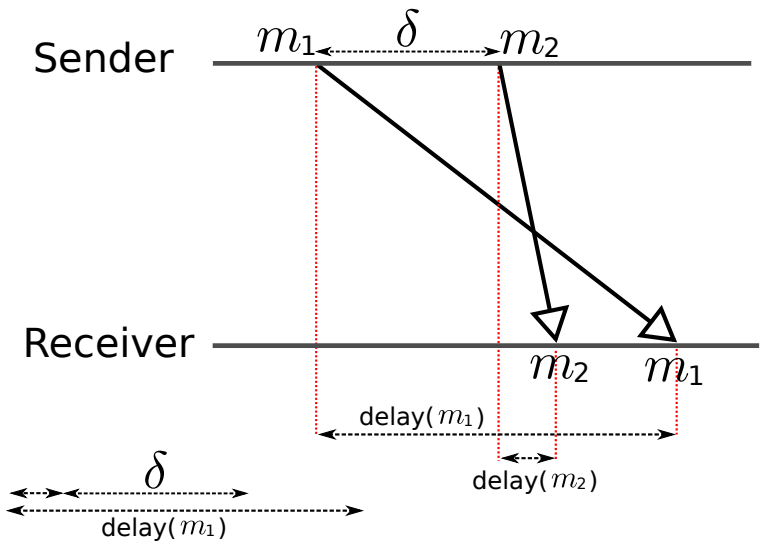

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- Probabilistic bounds can be found on this random variable (e.g. Bernstein inequality)
- In case of Siena B-DRP a Hypoexponential distribution fits the random variable

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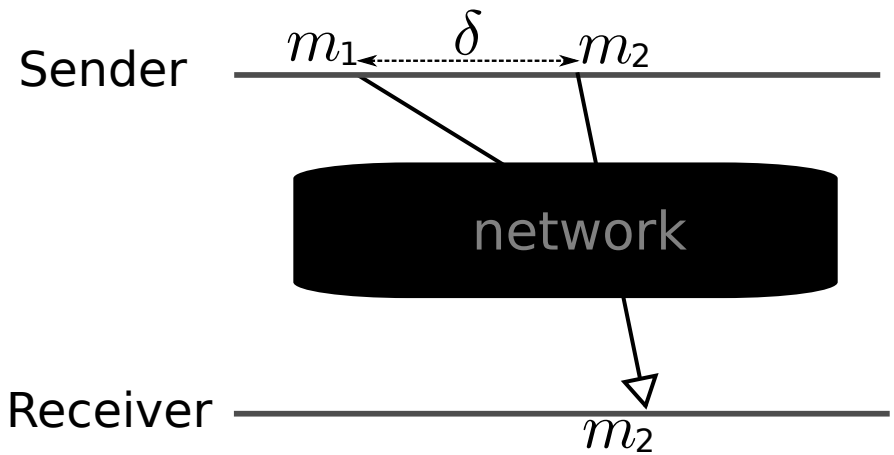
- Clock differences cancel out

Latch Time



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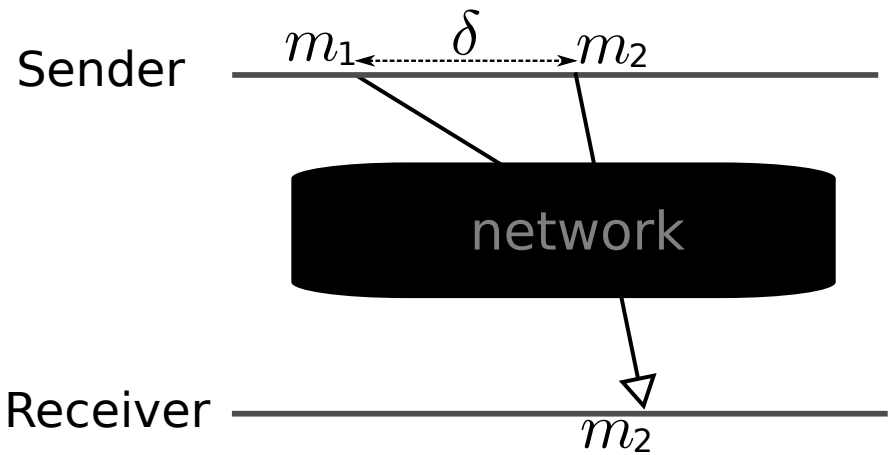

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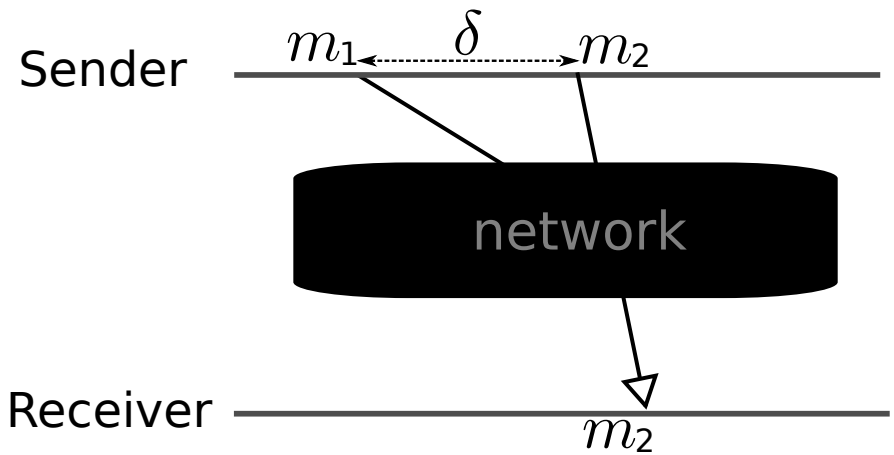

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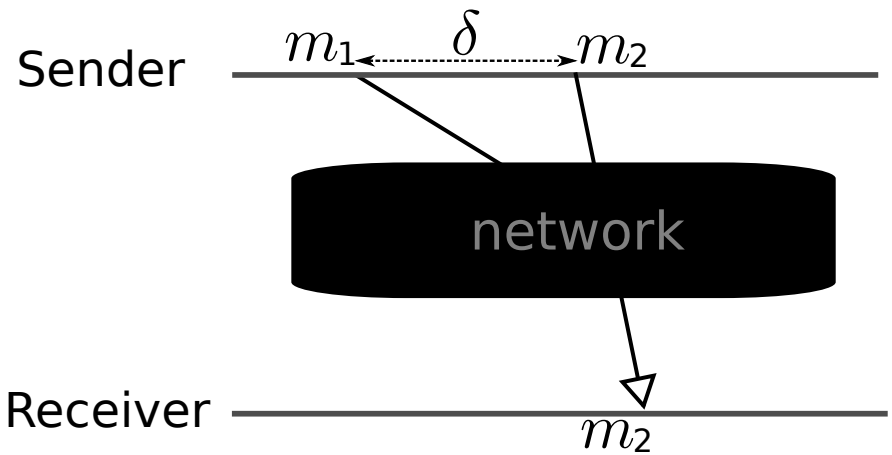

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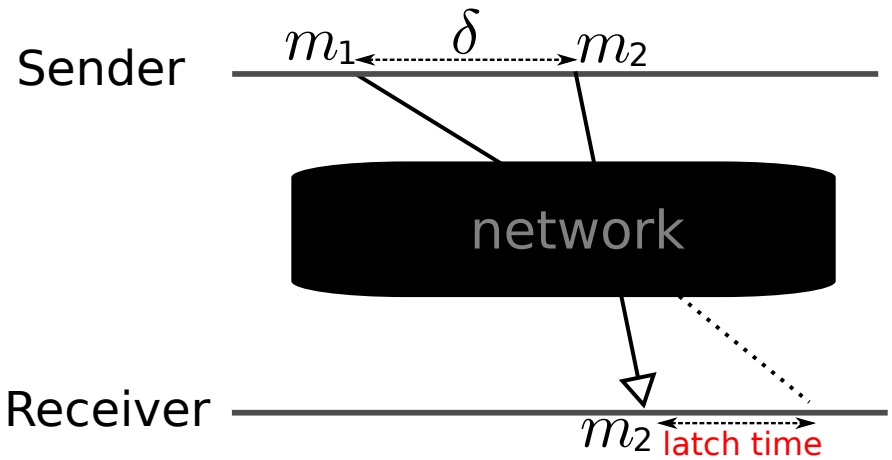

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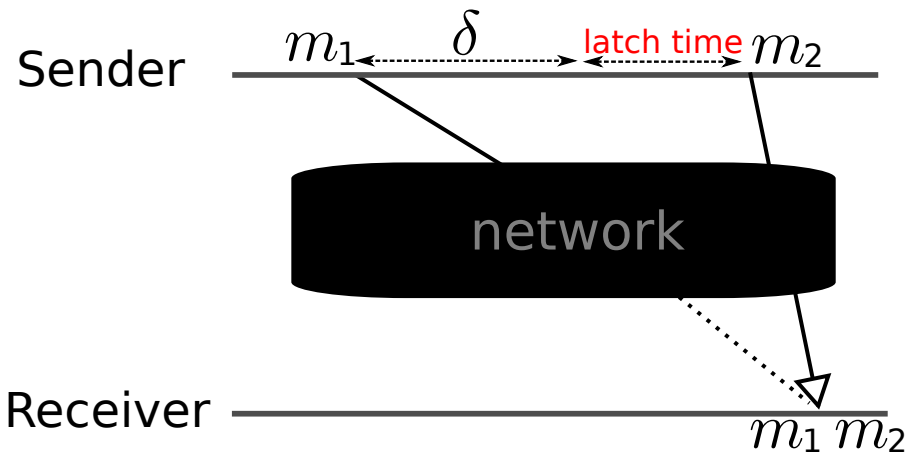

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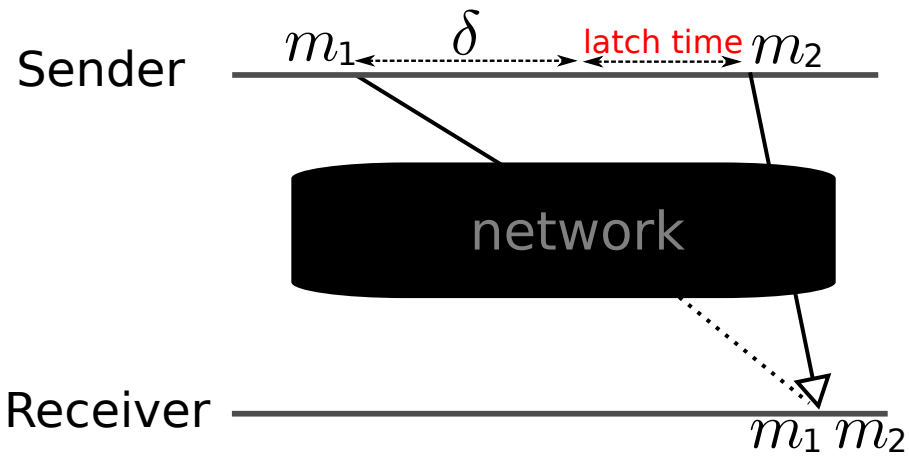

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- Pr(FIFO violation) $<$ Pr($delay(m_1) - delay(m_2) > \delta + \tau$) $< P_t$
- τ can be found using probabilistic inequalities or the Hypoexponential distribution

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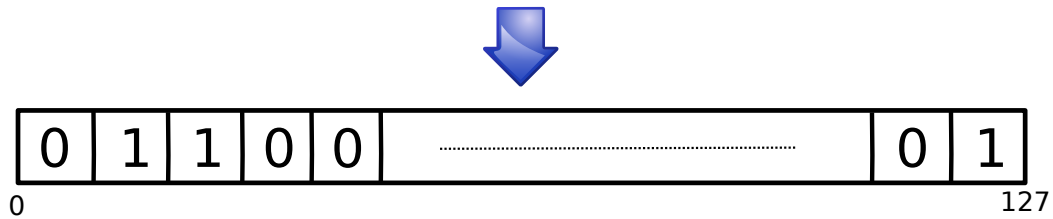

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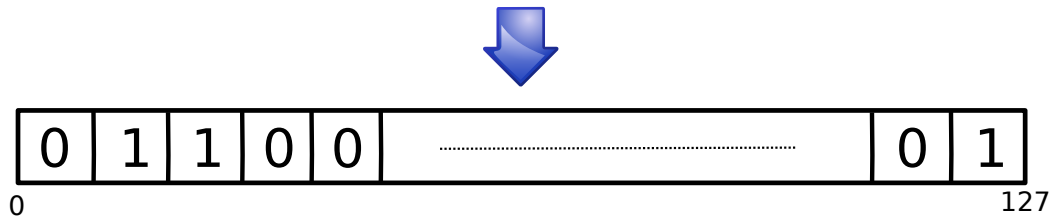
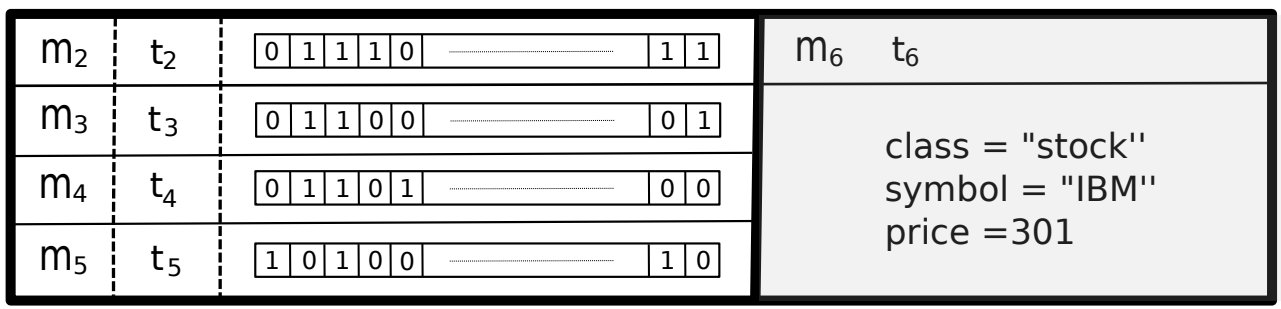


- Sender piggybacks each message with encoded summary of last k messages (**publication record**)



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- So if a missing message is not relevant we just don't wait for it

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- But again...pub/sub has its own particularities

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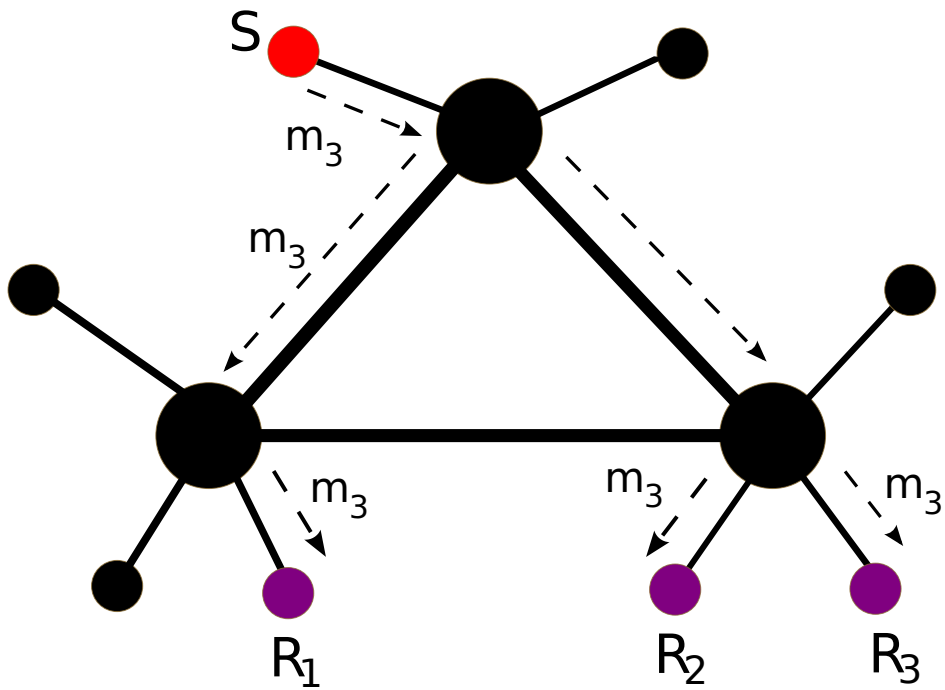
- We further enhance request routing with Bloom filters
  ▷ Additional constraint/attribute that give hints about the content of messages

Reliability: Example



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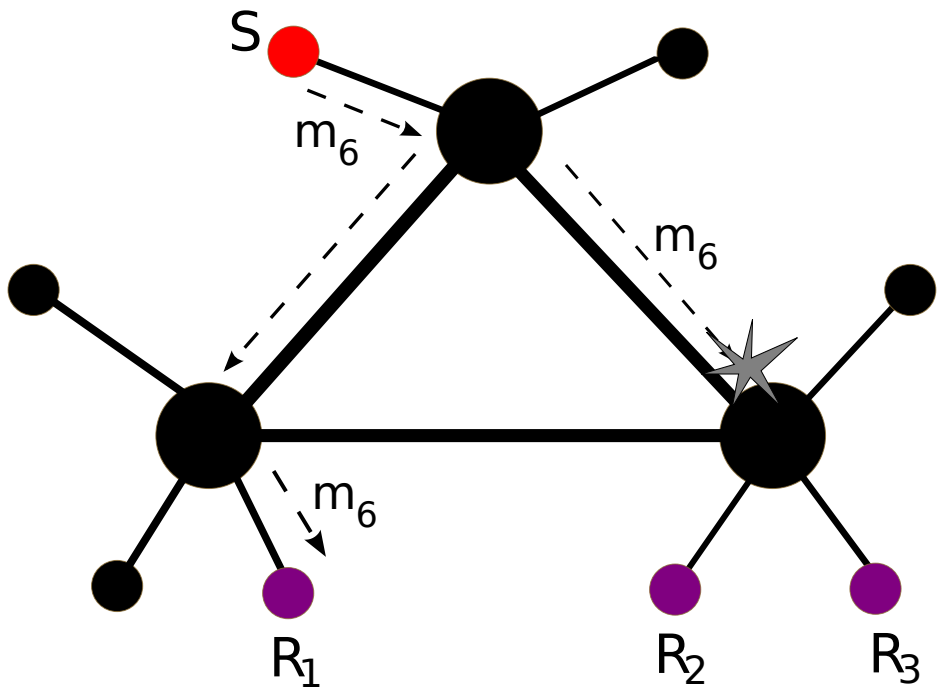

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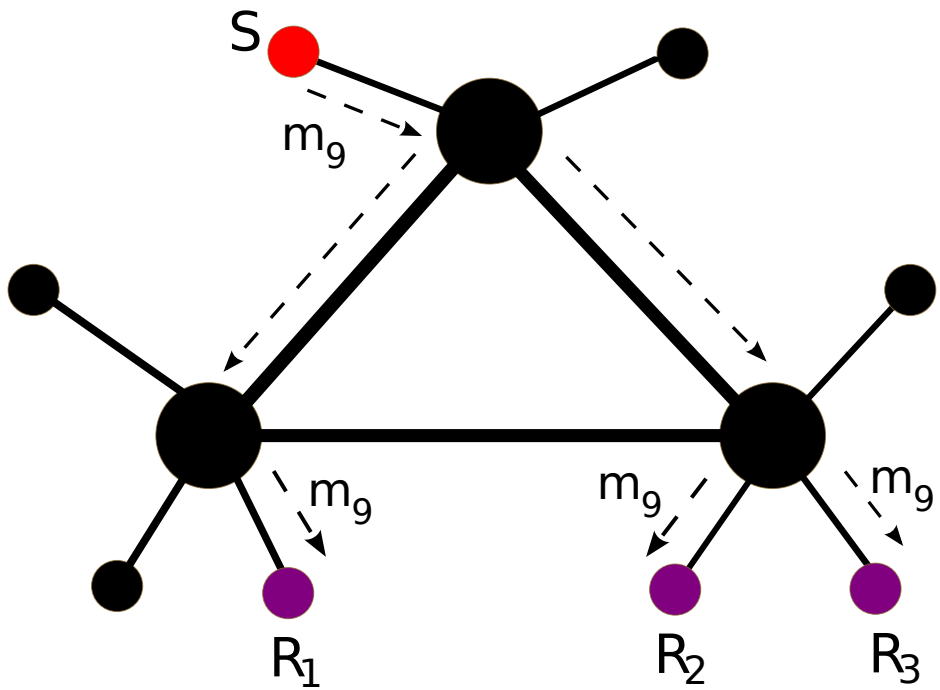

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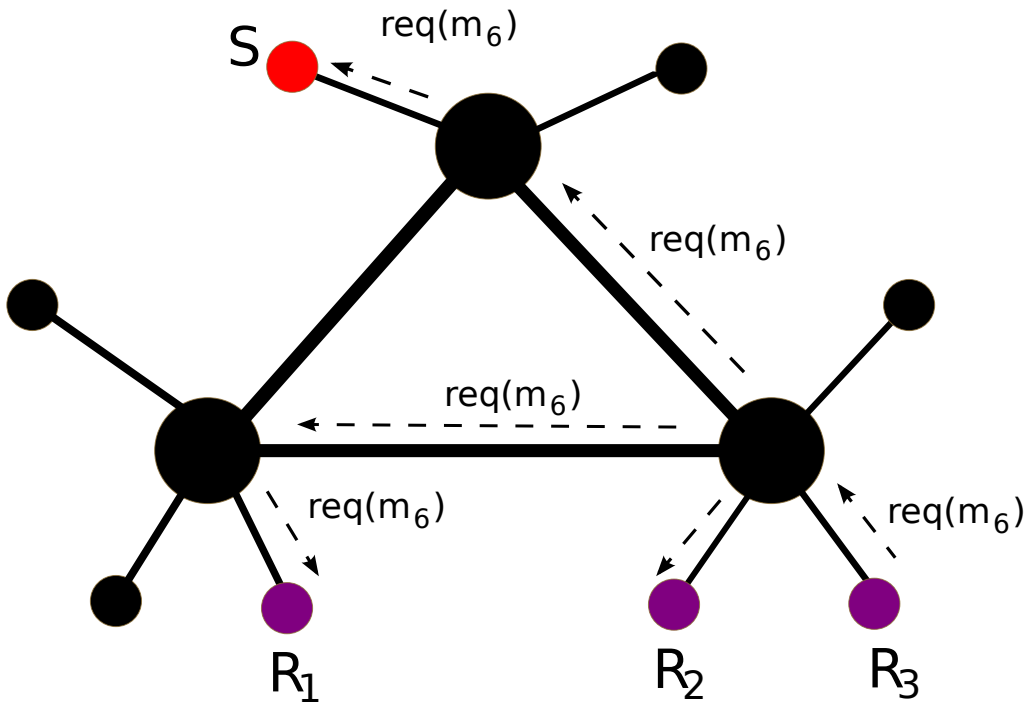

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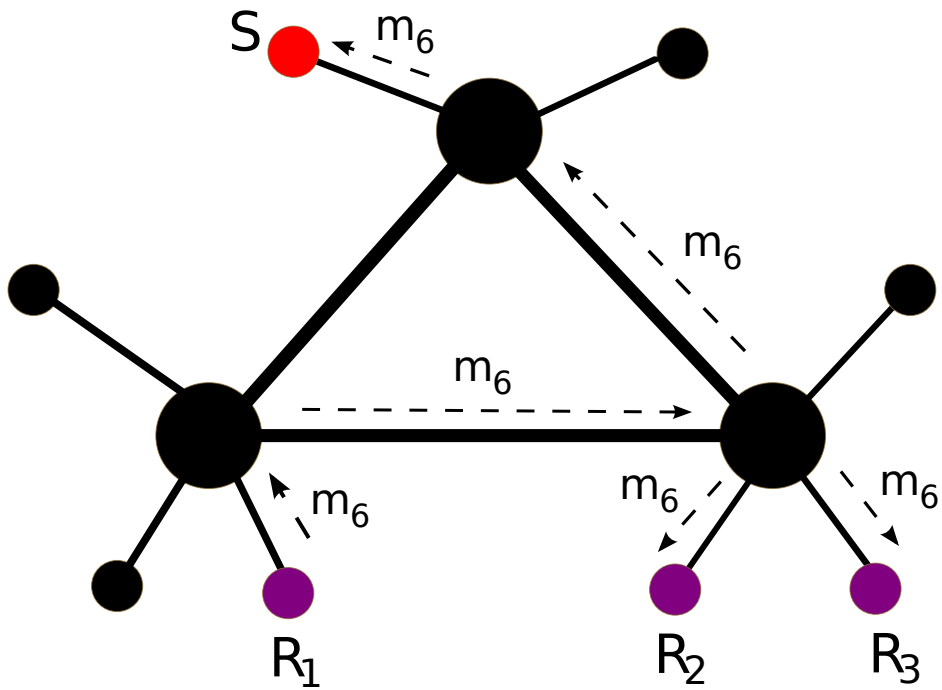

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- A pluggable module written in Java
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- With a small sacrifice of throughput and end-to-end delay

Future Directions

- Theoretical analysis of the protocol performance
- Better encoding schemes for publication record
  - ▷ Exploiting temporal locality of events

Thank you!

Questions?